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Brief Report

Bacterial contamination of saline nasal irrigations in children: An original research

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Key Words:
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Microbiologic analysis of nasal saline irrigations (NSIs) used in hospitalized children was performed.
Of 253 collected samples, 24.9% were positive, and the number of positive samples significantly increased over time ($P < .001$). *Staphylococcus aureus* was the most frequently detected bacterium (28.6%). None of the 118 patients who received NSIs developed a nasosinusal infection.
Colonization by cutaneous and environmental germs is frequent and develops early. Hygienic measures should be advocated to reduce contamination.

Nasal saline irrigations (NSIs) are used in patients with upper respiratory tract infections and allergic rhinitis.[1-4] A national survey documented that most Italian pediatricians consider them effective and well tolerated.[3] Different devices are actually available,[3] and NSIs performed by repeatedly resampling from a saline solution bottle by means of a bulb syringe are probably the easiest and most inexpensive approach.

Although NSIs are generally considered safe, bacterial contamination of the device may occur. Indeed, saline bottle bacterial contamination has been described.[5-9]

The aim of this study was to evaluate bacterial colonization of saline solution in children who underwent daily NSIs by the use of a syringe bulb and saline solution bottle.

METHODS

Materials

Samples of saline solution were taken from the bottles used for NSIs in children who were admitted to our hospital for lower respiratory tract infections and who were candidates for daily NSIs.

Exclusion criteria were acute nasosinusal infection; severe systemic disease (cystic fibrosis or Kartagener syndrome); neuromuscular, immunologic, syndromic, or genetic abnormalities; and parent refusal.

Interventions

Before the first use, the syringe needle was used to pierce the rubber bottle cap by the pediatric nurse; then the needle was removed and the syringe bulb was placed and left inside the pierced rubber bottle cap. Caregivers were instructed about the following modality to perform NSIs: after handwashing before each use, the syringe should be filled with saline solution and used for irrigation. Then it should be placed inside the pierced rubber bottle cap. NSIs were performed by the children's parents or by health care professionals.

Pediatric nurses were instructed to periodically pick up 5-mL samples of saline solution from the bottle by means of the syringe used for NSI (after handwashing and putting on disposable gloves). This was done just after the bottle opening (day 0), and then the day after (day 1, within 24 hours), 2 days after (day 2, 48 hours after bottle opening), 3 days after (day 3, 72 hours after bottle opening), 4 days after (day 4, 96-120 hours after bottle opening), 5 days after (day 5, 120-144 hours after bottle opening), and 6 days after (day 6, 140-168 hours after bottle opening). The samples were moved into sterile

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phials and delivered to the microbiologic laboratory to be analyzed within 2 hours.

Microbiological evaluation

Each specimen was immediately vortexed and cultured on Mueller Hinton agar, MacConkey agar, and Mannitol Salt Agar (Difco) under aerobic conditions and on Columbia blood agar (Difco) in a 5% CO_2 atmosphere at 37°C. The plates were first examined after 18-24 hours of incubation and then checked for the presence of bacterial colonies after 48 hours to detect slow-growing microorganisms. Microbial identification was performed at the genus and species level according to their typical colony morphology, Gram stain, and standard rapid tests and was finally confirmed by biochemical tests (API - BioMérieux).

Statistical analysis

Descriptive statistics were used to report the main results (given as absolute numbers and percentages or as arithmetic mean values ± standard deviation).

Dichotomous outcomes were analyzed using contingency table analysis by means of Fisher's exact test. Time-series regression analysis was used to evaluate the statistical trend of the percentage of positive samples over time. The characteristics of NSIs performed were tested as possible confounders.

RESULTS

The final analysis was based on 253 samples collected from bottles used for administering NSIs to 118 children (66, 55.9% males; mean age 17.0 ± 15.9 months).

The mean samples for each patient were 2.1 ± 2.8 (Fig 1). NSIs were performed by health care professionals and the children's parents in 43.5% and 56.5% of cases, respectively.

On microbiologic assessment, 24.9% of samples were positive. Bacterial contamination in at least 1 sample was detected in 22.0% of patients, and no significant difference in the number of patients with at least 1 positive sample was found when NSIs performed were separately considered (health care professionals = 21.5% vs. children's parents = 21.5%). Bacterial contamination occurred significantly (P = .003) earlier when NSIs were administered by health care professionals than by the parents, as 59.2% of positive samples among those collected by health care professionals were taken within 24 hours after the bottle opening, whereas only 17.4% of positive samples among those collected by the children's parents were taken within 24 hours after the bottle opening.

The number of positive samples at microbiologic assessment significantly ($P < .001$) increased over time, with a mean 14.3% (standard error = 0.1; $P < .001$) daily increase (Fig 2).

Staphylococcus aureus was the most frequently detected strain (28.6%) (Table 1). Polymicrobial contamination was found in 2.4% (6/253) of samples.

None of the patients developed signs of acute nasosinusal infection.

DISCUSSION

Bacterial contamination of saline solution bottles used for NSIs in children is not a rare event, as it occurred in approximately 25% of samples. Although no similar studies have been previously performed in pediatric patients, our findings are in line with the literature: a recent review of contamination in sinus irrigation devices used after functional nasosinusal surgery showed that the overall prevalence of positive samples ranged between 25% and 100%,[7] with *S. aureus* being detected as the main pathogen.

We documented a progressive significant increase in the number of contaminated samples over time. A not-negligible percentage of samples was found to be positive within 24 hours from bottle opening, suggesting that bacterial contamination occurs very early and confirming a previous report.[9]

No bacteria involved in upper airway infections have been isolated, as only germs generally located at the cutaneous or environmental surfaces have been discovered, with *S. aureus* and *Neisseria* spp. being the most frequently detected strains.

The absence of any sign suggestive of the development of acute nasal or nasosinusal infections in this cohort of patients seems to suggest the lack of a direct link between saline solution contamination and the occurrence of any infectious process.

Microbiologic results cause us to reflect on the importance of strictly respecting hygienic measures. This includes handwashing before NSI administration, to reduce the rate of bacterial contamination resulting from germs spreading from caregivers' hands and the surrounding environment. This derives from the observation that positive cultures were found significantly earlier when NSIs were administered by health care professionals than by parents.

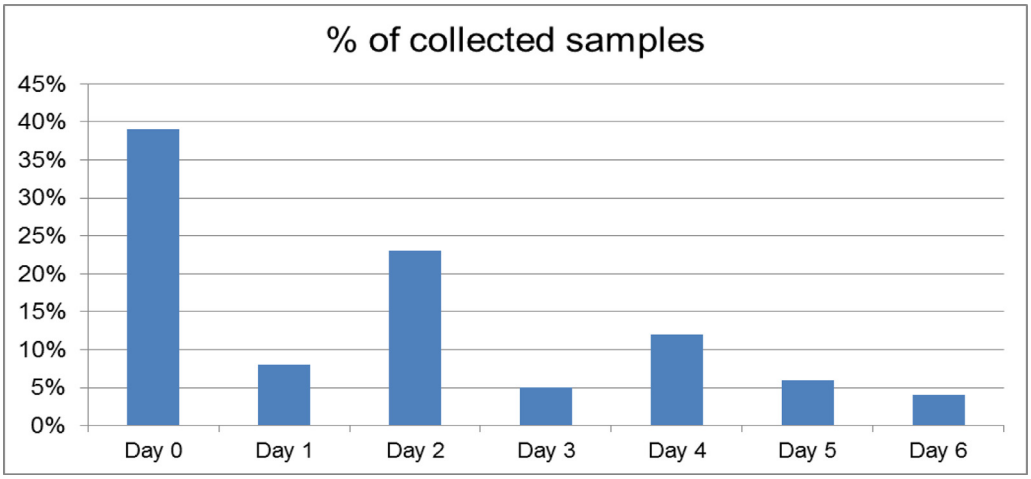

Fig 1. Rate of samples collected over time.

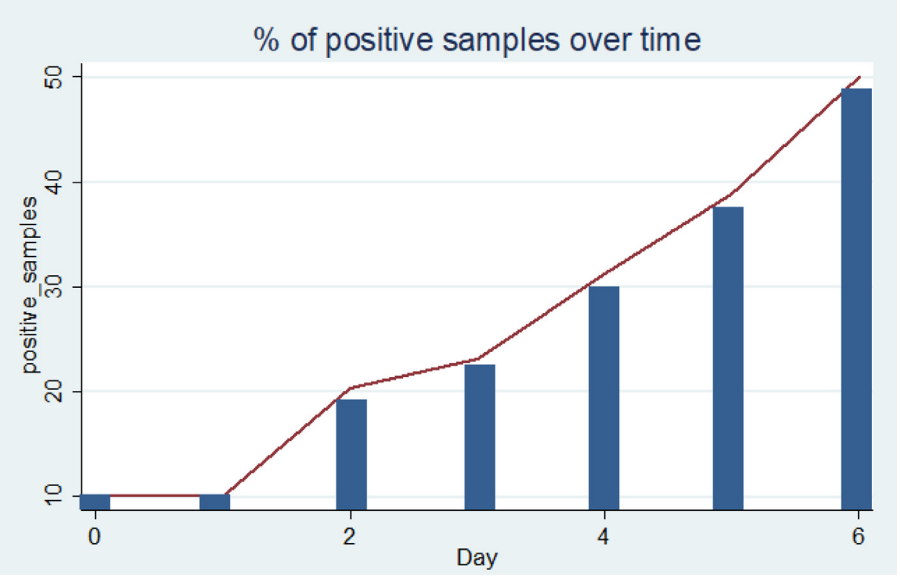

Fig 2. Rate of positive samples over time.

Table 1
Number and rate of samples with isolated bacterial strains.

Bacterial strain	Number of samples (%)
Staphylococcus aureus	18/63 (28.6%)
Neisseriae spp.	11/63 (17.5%)
Klebsiella pneumoniae	9/63 (14.3%)
Stenotrophomonas maltophilia	9/63 (14.3%)
Alcaligenes xylosoxidans	5/63 (7.9%)
Staphylococcus xylosus	3/63 (4.8%)
Escherichia coli	1/63 (1.6%)
Acinetobacter lwoffii	1/63 (1.6%)
Aeromonas	1/63 (1.6%)
Forme difteroidi	1/63 (1.6%)
Ocromobactum anthropi	1/63 (1.6%)
Pseudomonas aeruginosa	1/63 (1.6%)
Serratia liquefaciens	1/63 (1.6%)
Staphylococcus warneri	1/63 (1.6%)

CONCLUSIONS

Our study confirms the safety of NSIs in children and advocates their use as preventive and therapeutic means in patients with upper airway disease. They could possibly reduce the need for other therapies, such as antihistamines and antibiotics.

Moreover, our results document the presence of excessive bacterial flora in hospital settings and the possibility of bacterial translocation from caregivers and health care professionals. This advocates the importance of infection control aspects, including good hand hygiene and single-patient use, to reduce the rate of bacterial contamination.

References

1. Shaikh N, Wald ER, Pi M. Decongestants, antihistamines and nasal irrigation for acute sinusitis in children. Cochrane Database Syst Rev 2010:CD007909.
2. Kassel JC, King D, Spurling GK. Saline nasal irrigation for acute upper respiratory tract infections. Cochrane Database Syst Rev 2010:CD006821.
3. Marchisio P, Picca M, Torretta S, Baggi E, Pasinato A, Bianchini S. et al Nasal saline irrigation in preschool children: a survey of attitudes and prescribing habits of primary care pediatricians working in northern Italy. Ital J Pediatr 2014;40:47.
4. Hardy ET, Stringer SP, O'Callaghan R, Arana A, Bierdeman MA, May WL. Strategies for decreasing contamination of homemade nasal saline irrigation solutions. Int Forum Allergy Rhinol 2016;6:140-2.
5. Shargorodsky J, Lane AP. What is the best modality to minimize bacterial contamination of nasal saline irrigation bottles? Laryngoscope 2015;125:1515-6.
6. Psaltis AJ, Foreman A, Wormald PJ, Schlosser RJ. Contamination of sinus irrigation devices: a review of the evidence and clinical relevance. Am J Rhinol Allergy 2012;26:201-3.
7. Foreman A, Wormald PJ. Can bottle design prevent bacterial contamination of nasal irrigation devices? Int Forum Allergy Rhinol 2011;1:303-7.
8. Lee JM, Nayak JV, Doghramji LL, Welch KC, Chiu AG. Assessing the risk of irrigation bottle and fluid contamination after endoscopic sinus surgery. Am J Rhinol Allergy 2010;24:197-9.
9. Kofonow JM, Bhuskute A, Doghramji L, Palmer JN, Cohen NA, Chiu AG. One-way valve bottle contamination rates in the immediate post-functional endoscopic sinus surgery period. Am J Rhinol Allergy 2011;25:393-6.